

Strangled Waters

First Wave

On a balmy day in June 1955, George Anderson took his sailboat out on Lake Washington, the long stretch of fresh water that separates Seattle from its eastern suburbs. Anderson had recently finished his doctoral research on phytoplankton, and knew the lake well. The water that day looked odd; he noticed a strange brown tinge. So he collected a sample in an empty beer bottle and brought it back to the University of Washington lab where he worked with his mentor, W.T. Edmondson, the ranking authority on the lake.

Under the microscope, Anderson and Edmondson found a life form they'd never seen before. It grew in long, narrow chains, striated with lines that separated one cell from the next. They thought this might be a species infamous among limnologists, the cyanobacterium *Oscillatoria rubescens*. (Cyanobacteria, popularly known as blue-green algae, are in fact distinct from and far more ancient than algae. They appeared more than 3 billion years ago, when the planet was inhabited only by microbes, and were the first organisms to evolve photosynthesis. Their proliferation and release of great volumes of oxygen profoundly changed the chemical makeup of Earth's atmosphere, making the evolution of complex life possible.)¹

The researchers needed to be sure, so they sent a sample off to an expert, who confirmed their suspicions. *O. rubescens* signaled deteriorating conditions in Lake Washington. To Edmondson, it also meant an unprecedented opportunity to track the impacts of nutrient overload.²

O. rubescens had been the harbinger of drastic change in a number of western European lakes. The best-known case was that of Lake Zurich in Switzerland. Fed by Alpine glaciers, Lake Zurich was, until the late 1800s, an expanse of blue known for its abundant populations of whitefish and lake trout, which thrive in deep water. The lake is made up of two basins separated by a narrow passage. In the late nineteenth century towns at the edge of the lower basin, the Untersee, abandoned privies for flush toilets, and began to release their raw sewage into the lake.

In the summer of 1898, a bloom of *O. rubescens* turned the Untersee a bright shade of magenta. Trout and whitefish vanished. The upper basin, the Obersee, received little sewage and remained clean and populated with the normal array of native fish, serving as a control for the unplanned experiment in pollution of the lower basin.³ By the 1930s, *O. rubescens*, the cyanobacterium that had never been found in Lake Zurich before sewage began to flow, had become dominant. In 1936 it formed a stinking red scum that covered the Untersee's surface.⁴

Lakes scattered throughout North America and Europe were replaying Lake Zurich's disaster. All these bodies of water were choking on an overdose of nutrients unleashed by human actions—a syndrome ecologists named *eutrophication*, based on the Greek phrase for “well fed.” In summer, these lakes would turn bright green with dense blooms of algae (or sometimes, as in the case of Lake Zurich, an angry red). As the algal cells died off, they sank to the bottom, where bacteria consumed oxygen in the process of decomposing them. As a result, dead zones appeared—areas of deep water drained of dissolved oxygen, where fish could not survive. Over time, eutrophication has driven the extinction of several species of whitefish endemic to the lakes of the European Alps.⁵ It has profoundly altered aquatic ecosystems in North America, too.

Edmondson's first glimpse of *O. rubescens* was “wildly exciting,” he wrote.⁶ It meant that Lake Washington was in worse shape than he had expected. But it also meant a chance to “turn the clock back fifty-seven years and see what must have happened to Lake Zurich.”

Seattle had dumped raw sewage into Lake Washington in the city's early decades. By the 1930s the lake's waters were unsafe for drinking or swimming, so Seattle diverted its sewage to Puget Sound. As the city continued to grow, small towns sprang up on Lake Washington's eastern shore. In 1955, ten secondary treatment plants were pouring 20 million gallons of effluent a day into the lake from the eastern suburbs. Secondary treatment breaks down organic matter, but it doesn't remove nitrogen and phosphorus, which fuel algal blooms. In fact, the treatment process releases these nutrients in inorganic forms—like phosphate (PO₄) and nitrate (NO₃) that are readily absorbed by algae. A 1950 study by Edmondson's students showed that the concentration of phosphate in the lake had doubled, and levels of dissolved oxygen in deep water had begun to decline. Edmondson's lab tracked a steady increase in algal abundance, even before the appearance of *O. rubescens*. The water became progressively murkier. Transparency, measured by the depth to which a white, eight-inch Secchi disc is visible below the surface, decreased from twelve feet in 1950 to two and a half feet in 1958.⁷

On Seattle's western waterfront—in Elliott Bay, an arm of Puget Sound, and along the shore of the Sound itself—water quality was terrible. Four primary treatment plants discharged to Elliott Bay, and forty-eight outfalls dumped 70 million gallons of raw sewage into Puget Sound daily. The Sound's beaches stank, and most were closed due to heavy contamination with coliform bacteria.⁸

A Seattle lawyer, James Ellis, was trying to work out a political answer to greater Seattle's water pollution dilemma. Ellis represented several of the small sewer districts on the eastern shore of Lake Washington. He knew that none of

the districts had the resources to handle their growing sewage loads, and believed the only lasting solution would require the separate communities to work together. Engineers at the Bellevue sewage district, in the center of the east shore, came up with the idea of building a sewer line that would extend south, collecting effluents from other towns along the way, and discharge into Puget Sound. The neighboring sewer districts refused to cooperate, so the idea had to be put aside.

In 1956, Edmondson read a newspaper article that implied a committee led by Ellis was considering enlarging the existing secondary sewage plants on Lake Washington. He wrote to Ellis, explaining the basic principles of limnology and the reasons why more treatment wouldn't solve the problem. Ellis replied with enthusiasm. He understood Edmondson's point—the issue in Lake Washington was heavy loads of nitrogen and phosphorus, which would not be controlled by secondary treatment. He agreed that the ultimate solution must be to divert sewage from Lake Washington to the deep waters of Puget Sound, far from shore. This would involve a major public works project, to build a sewer line that would collect wastewater from all the treatment plants on the lakeshore and carry it to the sound.

The first step was to create a government agency that would have jurisdiction over the entire region and the ability to increase sewage bills for every household served. Ellis drafted legislation to create the Municipality of Metropolitan Seattle, called Metro for short. His original proposal would have given Metro control over garbage disposal, water supply, transportation, and parks in addition to sewage. It was rejected by voters in the spring of 1958.

During the hot summer of 1958, the lake began to stink, and many beaches were closed. Mayors of some of the suburban towns took the lead in reviving a simplified version of Metro, with sewage disposal as its only mission.⁹ The League of Women voters and hundreds of other volunteers campaigned for the new legislation. To make their point, Metro advocates used a photo of a sad clump of children at a beach where swimming was forbidden. They repeated warnings from Edmondson that unless things changed, Lake Washington would continue to get worse.

The revised Metro was approved by voters in the fall of 1958. The new law enabled the sale of revenue bonds to fund sewer line construction. Sewer bills for Seattle-area homes went up by about \$2 per month.

Sewage was diverted from the lake gradually, as construction moved ahead and the interceptor pipe reached more of the lakeshore treatment plants. The first diversion was finished in 1963, removing 28 percent of the total sewage effluent. Lake Washington's phosphorus levels, algal abundance, and turbidity, which had been increasing steadily for years, stabilized. Meanwhile, a new secondary sewage treatment plant was built on the Duwamish River, the lake's outlet, to replace the ten smaller plants to be abandoned on the eastern shore. Three primary plants were built at the edge of Puget Sound, designed to end all raw sewage discharges and move effluents into deeper waters where tides would flush them out to the Pacific. A total of 110 miles of interceptor sewer lines and nineteen pumping plants were needed to channel sewage to treatment plants in the new Metro system.¹⁰

In 1967, when the new sewer line was nearly complete, water quality in Lake Washington improved dramatically. Phosphorus concentrations and algal densities dropped, and transparency increased to nine feet.¹¹ By 1971, beaches on the shore of both the lake and Puget Sound were safe and open to swimming.

The rescue of Lake Washington was unique: The people living on its shores had campaigned for the Metro system and voted to pay what it took to clean up the lake. As concern over water pollution grew across the US, the lake's story was trumpeted as a rare model of success. The President's Council on Environmental Quality cited Seattle's Metro project as one of the two outstanding antipollution projects in the nation.¹² (The other example was San Diego Bay, which had also been restored through construction of a vast network of pipes carrying sewage to the sea.)

Ignored was a small sewage rebellion in the town of Santee, California, east of San Diego. When Santee was pressured to sign a forty-year sewage disposal contract with San Diego's regional sewage system, the town refused. "We decided," said Ray Stoyer, head of Santee's water district, "that long before a forty-year disposal contract with San Diego ended, wastewater could become a water resource, not a liability that you pay to get rid of."¹³

Santee already had a secondary sewage treatment plant, which had been discharging into Sycamore Creek. Now the state was requiring that the town end its release of effluent into the creek. Stoyer came up with the idea of filling abandoned gravel mines near the treatment plant with effluent to create a series of lakes. To raise the quality of effluent and ensure the waters would be safe for fishing and boating, he built a series of gravel filtration beds, where treated effluent was made cleaner by bacteria clinging to the rocks. The lakes (Stoyer began with one and ended up with a chain of seven) were stocked with trout and catfish, surrounded with trees and grass, and attracted crowds of anglers and picnicking families, who relished the oasis in the arid landscape. In 1964, after years of extensive testing, the California Department of Public Health announced the fish were safe to eat and the water was safe to swim in.

Southern California relied on expensive water imported from the Colorado River, and later, from the State Water Project, which brought water from the northern half of the state. Santee's reclamation process produced usable water at one-fourth the price of Colorado River water. At one point, the Santee water district predicted it would be able to produce effluent clean enough to pump into drinking water supplies.¹⁴ But by 1974, when Arcata first began to rebel against the state's plan for a regional sewage system in Humboldt County, the popularity of the Santee Lakes had defeated Stoyer's strategy to avoid hooking up to San Diego's regional system.

The lake reclamation system was designed to handle 1 million gallons of wastewater per day, and at first, that was fine. But the greenery and open water created by Santee's sewage drew more than 250,000 visitors a year, and property near the treatment plant and lakes sprouted new homes at a rapid pace. Soon Santee's plant was producing 4 million gallons of effluent per day, the result of increased sewage flow from a growing population. The Santee plant released

excess effluent to the bed of the San Diego River, which normally went dry in summer. The sewage flow created year-round pools in the river bed, where mosquitoes bred. The San Diego Health Department ruled that these pools were a health hazard, and that discharges to the river must stop.¹⁵

The Santee water district was forced to hook up to the Metro sewage system to dispose of its excess sewage. At first town officials feared this would spell the end of the artificial lakes, but they've endured, and remain a popular recreation spot.

San Diego's regional sewage system, meanwhile, was reaching overload. The Point Loma sewage plant, which used only primary treatment, was discharging the sewage generated by nearly 3 million people in the San Diego area to the Pacific. In the late 1980s, the San Diego wastewater system was sued by the US Environmental Protection Agency (EPA) for polluting the ocean, and forced to upgrade its treatment. It was the beginning of the end of the philosophy that the ocean could take whatever humanity dumped in it, that dilution was the solution to pollution.

By 1989, the San Diego Regional Water Quality Control Board, which decades earlier had resisted Santee's reclamation project, was citing it as an example of the kind of creative water reuse that was needed for Southern California's survival. Water demand in the San Diego area was climbing above the amount allotted by the State Water Project, with no new water sources in sight. "It's implicit that we're not going to get more water," said John Foley, chair of the San Diego Regional Water Quality Control Board. "We've got to look at conservation and reuse, or we've got to look at one hell of a change in our life styles."¹⁶ Ultimately, San Diego's Metro sewage treatment system was redesigned to include multiple treatment plants that could channel treated effluent to irrigate parks and golf courses throughout the county—a shift in engineering that would allow sewage to be treated and reused where it was generated, rather than pumping it great distances to dump it in the ocean.

In the mid-twentieth century, though, the idea of elaborate regional sewage projects as the key to saving US waters took hold. It would shape the historic Clean Water Act (CWA) of 1972.

The Great Lakes, five giant bodies of fresh water that fan out along the US–Canadian border, had been presumed immune to eutrophication due to their sheer size. But by 1960s, some of the Great Lakes showed obvious symptoms of decline. On Lake Michigan's southern shoreline, Chicago's beaches stank from the rotting mats of algae that waves deposited on the sand. The city's complicated dodge of routing its sewage away from Lake Michigan and into the Illinois River Valley had only slowed the lake's decline. Chicago's growing population overwhelmed its sewage system, adding to pollution from other lakefront cities and industries.

Erie, the southernmost of the Great Lakes, was known as "America's Dead Sea," the most polluted body of water in the US. An oily scum floated on the surface, along with discarded chunks of wood, beer cans, soda bottles, and the rotting bodies of fish. People were warned away from its beaches because of coliform bacteria in the water, sometimes orders of magnitude higher than levels considered safe for swimming.

Sewage treatment in the cities ringing the lake was primitive. In the Cleveland metropolitan area, only three of fourteen cities had secondary sewage treatment plants in 1966; all discharged their effluents directly to the lake. Cleveland itself had an antiquated sewer system that routinely failed in times of heavy rain. Stormwater overloaded the pipes, causing raw sewage to flow into the lake. David Blaushild, a Chevrolet dealer with a passion for clean water, was suing the city for its failure to stop the discharge of untreated industrial waste into the Cuyahoga River, which bisected Cleveland on its path to Lake Erie. The polluters included Republic Steel, US Steel, Harshaw Chemical, and Reserve Oil Refining Company.¹⁷

Jeff Reutter, a limnologist who has spent a lifetime studying Lake Erie, remembers swimming there as a kid in the 1950s: Clumps of human feces floated in the water beside belly-up fish. In the 1960s, when Reutter was a teenager commuting to his first job in downtown Cleveland, he passed a rusting metal breakwater on his way to work. It bore a desperate message painted in dripping white letters: “Help me. I’m dying. Signed, Lake Erie.”

The most prized commercial fish, walleye and blue pike, were dwindling as Lake Erie’s oxygen-depleted dead zone expanded.¹⁸ In the spring of 1965, when Ohio Governor James Rhodes convened a conference on Great Lakes pollution, the situation was dire. Ernest Premetz, chief of the US Bureau of Fisheries based at Ann Arbor, Michigan, informed the conference that blue pike, a species unique to Lake Erie, was extinct. “Walleye are about gone, and whitefish and yellow perch are going,” he said. Mayflies, whose larvae live on the lake bottom and form a critical food source for fish, had vanished from Lake Erie after the shallow western basin went anoxic in the late summer of 1953.¹⁹

The lake was as productive as ever, but because it was overloaded with nutrients, it grew algae and shallow-water fish like carp, sheepshead, and smelt—which nobody wanted to eat. Prized food fish, denizens of deep water like the walleye, became scarcer and smaller year by year. “The commercial catch this year in Lake Erie,” noted Premetz, “will be the poorest in history.”²⁰

Speakers at the conference also discussed the human health hazards of drinking water drawn from Erie and other polluted lakes, the absence or routine failure of effective sewage treatment, and the lack of control on industrial discharges. Within a few weeks of the Cleveland conference, Governor Rhodes sent a letter to the US Department of Health, Education and Welfare pointing out that major sources of Lake Erie pollution lay outside the state of Ohio, and asking that the federal government take responsibility. This triggered an investigation by the US Public Health Service.

Rhodes timed his request to coincide with another water pollution conference, one focused on the plight of the Detroit River, which carried the wastes of Detroit and its industries to Lake Erie. “The Detroit River took on many shades of the rainbow, from pea green, bright lemon-orange, crimson, and deep brown—all streaked with black oil,” wrote a reporter for the *Cleveland Plain Dealer*, describing a twenty-mile boat trip the conferees took ending in downtown Detroit.²¹

The Detroit River and Lake Erie had long been important habitats for water-fowl. Antoine de Lamothe Cadillac, Commandant during the founding of Detroit, had

described the river's abundance in a 1701 report to his superiors. "The fish there are fed and laved in sparkling and pellucid waters . . . There are such large numbers of swans that the rushes among which they are massed might be taken for lilies," he wrote. The river hosted so much game, one of the native people told Cadillac, "that it only moves aside long enough to allow the boat to pass."²²

In its lower half, the Detroit River divides into narrow channels braided with shallows. It's an ideal habitat for ducks, geese, and the aquatic plants and small creatures they eat. For centuries after Detroit was settled, the food-rich lower river froze solid in winter, and waterfowl flew away until the thaw. Early Detroit residents raced horses across the ice, and in the Prohibition era, cars loaded with bootleg liquor drove across the river by night. Then, when industrial plants sprouted on the river's west bank in the 1930s, the thaw became permanent. Effluent from auto and steel plants warmed the water enough to keep it ice-free all year, and waterfowl began to stay through the winter. About 50,000 birds wintered on the lower Detroit River in the early years of the auto industry.

Pollution from the plants—especially discharges of oil—would turn the river into a deathtrap. Oil soaks the feathers of water birds, destroying their insulation and leaving them to die of exposure. In warmer weather, oiled birds may slowly starve, unable to fly in search of food. Oil slicks were a regular feature of the Detroit River in the mid-twentieth century. Mass kills of ducks occurred every year from 1948 to 1960, the worst event wiping out an estimated 12,000 birds.²³ Some oiled birds were done in by as little as half a gram of lubricating oil on their feathers.²⁴

The Detroit water pollution conference was the perfect moment for Rhodes to make his point. The Detroit River carries 90 percent of the water that enters Lake Erie. In addition to the industrial discharges, Detroit's wastewater treatment plant, among the nation's largest, used only primary treatment and sent heavy loads of pollutants into the river—a trait it shared with plants in many Ohio cities that discharged directly into Lake Erie. "We are past the talking stage, and past the deploring, the study and the study-the-study stage," Rhodes told reporters. "Any further delay is inexcusable. The subject has been talked to death."

The studies and the talking, of course, went on—and so did the pollution. City officials blamed the state. States blamed neighboring states and the feds. People went on passing the buck, flushing their toilets, manufacturing steel and automobiles. Nothing much changed until June 1969, when a spark from a train wheel ignited the Cuyahoga River's chronic oil slick. The heat from that blaze drove a revolution in US water quality law (Figs. 5.1 and 5.2).

Jim Donovan, a longtime environmental activist who worked at the Jones & Laughlin steel mill in the 1960s, describes the blighted Cuyahoga of that era. "It was like a cauldron, with a coat of oil on it and gases bubbling to the surface," he says.²⁵ "You'd see rats floating downstream, bloated to the size of dogs." Oil slicks floating on the river's surface caught fire on a regular basis, and clouds of black smoke billowed from the water. The problem was an old one: A 1912 river fire had killed five dock workers. The most spectacular river fire blazed in 1952, causing \$1.5 million in damage, and might have burned downtown Cleveland to the ground if the wind had not shifted at the right moment.



Figure 5.1 Cuyahoga River fire, 1952. Photo courtesy of the Cleveland Press Collection, Cleveland State University Library.



Figure 5.2 Cleveland Councilman Katalinas, Henry Sinkiewicz, and John Pilch examine cloth soaked in oil from the Cuyahoga River, September 1964. Photo courtesy of the Cleveland Press Collection, Cleveland State University Library.

When Cleveland newspapers reported on earlier river fires, their stories focused on damage to railroad trestles and other industrial structures. The fouling of the Cuyahoga was a routine part of the city's business, seen by many as the normal price of prosperity. By the 1950s, steel mills and other industries had begun to control their releases of oil and grease—not to revive the river, but to protect their property from going up in smoke.

The fire of June 22, 1969, was the Cuyahoga's last. It burned for only half an hour, but it happened at a moment when a national movement for environmental protection was building. Six months earlier, in January 1969, an oil well off the coast of Santa Barbara, California, had blown, spewing 3 million gallons of crude into the Pacific. The tide carried thick deposits of oil and thousands of dying seabirds onto the beaches. The damage was so obvious and intense that hundreds of local people came out to help, trying to soak up oil with bales of straw and attempting to treat the oiled birds. "Never in my long lifetime," wrote Thomas Storke, editor of the *Santa Barbara News Press*, "have I ever seen such an aroused populace at the grassroots level. This oil pollution . . . has united citizens of all political persuasions in a truly nonpartisan cause."²⁶

President Nixon traveled to Santa Barbara to view the damage. The federal government carried some responsibility for the disaster: The US Geological Survey had granted Union Oil, the owner of the failed well, a waiver to use a shorter-than-standard pipe casing, and the failure of the casing triggered the well's blowout. In the aftermath of the oil spill, a declaration of environmental rights, written by University of California–Santa Barbara professor Roderick Nash, was read into the Congressional record. Nash's statement, along with widespread grassroots outrage over both the oil spill and the Cuyahoga River fire, framed the conversation that led to passage of the National Environmental Policy Act later in 1969.²⁷ The new law led to the establishment of the EPA.

Soon after the spill, Senator Edmund Muskie of Maine put forward new legislation that would impose stiff fines for the discharge of oil into US waters. Muskie had plans for more ambitious water quality legislation that would mandate improved treatment of sewage and industrial discharges nationwide. Rather than pushing that broader bill forward right away, however, he decided to wait and see how Richard Nixon's new administration would respond.

In August, *Time* magazine mentioned the river fire in a piece on water pollution. "Some river!" read the article. "Chocolate brown, oily, bubbling with sub-surface gases, it oozes rather than flows." Clevelanders, the article claimed, joked that a man who fell into the Cuyahoga would not drown—he'd decay instead. The story was illustrated with a dramatic photograph of a boat caught up in tall flames on the Cuyahoga—an image captured during the intense 1952 river fire. No photos of the brief blaze of June 22, 1969, are known to exist.

The *Time* story caught the nation's attention. "A river lighting on fire was almost biblical," former Sierra Club president Adam Werbach said in a 1997 interview. "And it energized American action because people understood that that should not be happening."²⁸

On June 23, the day after the fire, Cleveland Mayor Carl Stokes held a press conference. He announced that pollution of the Cuyahoga was beyond the city's

control, and that he was filing a formal complaint with the state. “We have no jurisdiction over what’s dumped in there,” he told a reporter for the *Cleveland Plain Dealer*.

State officials argued that even with no industrial discharges at all, the Cuyahoga would remain tainted by Cleveland’s failing sewage system. Ben Stefanski, Cleveland’s public utilities director, pointed out that any real solution to the problem would take serious money. Cleveland voters had approved a \$100 million bond issue to upgrade the city’s sewage system in November 1968, but that wasn’t enough to do the job. “Without federal funds, we’re in a bind,” Stefanski said. “We can’t tax our people any more . . . and how can we criticize industry for not taking greater steps to halt river and lake pollution when the city itself is one of the violators?”

In September, NBC aired an hour-long television documentary, “Who Killed Lake Erie?” The film was packed with ugly footage of untreated sewage spouting from pipes, scum and debris floating on the lake, dying wildlife, beaches awash in fish carcasses, and grim comments from local people. “One of these days the lake will get thick enough to cross it in a snowmobile,” opined the captain of a Niagara Falls tour boat. Leslie Fiedler, a famous literary critic who taught at the State University of New York in Buffalo, described the wind blowing off Lake Erie. “The smell of pollution and corruption that you get is the smell of death,” he said. “Not just the death of the lake, but of the people who live by it.”

NBC’s narrator drove home the point that Lake Erie’s plight was just one dramatic example of a nationwide pollution crisis. “Who killed Lake Erie?” his voice intones at the end of the video. “If it dies, we all did. We are all its murderers.”

The documentary set off a new round of political finger-pointing. Walter Hickel, Secretary of the Interior in the Nixon administration, announced a series of hearings to look into the failure of Ohio’s Water Pollution Control Board to act against polluters. This brought outraged complaints from Ohio officials.

Governor Rhodes laid the blame on Detroit. “We have too many federal bureaucrats who refuse to venture to the source of Lake Erie’s pollution,” he said. “They ought to go up the Detroit River with a short paddle.”²⁹ Rhodes liked to claim that 90 percent of Lake Erie’s pollution came downstream from Detroit—a myth adopted by other besieged Ohio officials. Much of the pollution in the 1960s was discharged directly into the lake from cities and industries in Ohio.³⁰

Meanwhile, an alarming realization was dawning on limnologists studying lakes in Europe and North America. The process of over-enrichment with nutrients, algal blooms, and oxygen-depleted waters was speeding up. The acceleration had begun in 1947, when Procter & Gamble put Tide, the first heavy-duty laundry detergent, on grocery store shelves. By 1953, phosphate-based detergents had usurped the market for old-fashioned laundry soap and were enabling the rise of the automatic dishwasher.

Human waste is rich in phosphorus, and sewage effluents had always carried high levels of the nutrient. By 1969, detergents accounted for half the phosphates in municipal sewage, and overall phosphorus loads had reached unprecedented levels. Secondary sewage treatment did a good job of breaking down organic matter and

reducing bacterial loads but failed to remove elemental nutrients like phosphorus and nitrogen.

In 1969, the same year that *Time* covered the Cuyahoga's final river fire, the US–Canada International Joint Commission released a report on pollution in Lakes Erie and Ontario. The commissioners identified phosphorus as the critical nutrient causing algal blooms in the lakes and urged an immediate decrease in the amount of phosphate used in detergents, and a complete ban within two years.³¹ The key role of phosphorus in eutrophication had long been suspected by limnologists, and a federal committee studying Lake Erie had urged drastic reductions in phosphorus loading as early as 1966. But the assumption had always been that the stuff would be removed by adding a chemical precipitation treatment to traditional sewage plants.

The notion that the \$45 billion detergent business would have to clean up its own act shocked the industry. At a Capitol Hill hearing called by Representative Henry Reuss, a Democrat from Wisconsin, industry representatives defended their product on the grounds that detergent phosphate was no worse than phosphate in human waste, and that removing the phosphorus from detergents would, on its own, not be enough to halt eutrophication. Reuss, who was sponsoring a legislative ban on phosphate in detergents, pointed out that removing phosphorus from sewage would be an expensive process that could take years to implement. At the time, less than 15 percent of the US population was served by plants capable of secondary treatment, let alone the added step of phosphorus removal.³² Taking the phosphate out of detergents could cut lake enrichment in half in one fell swoop.

The soap industry took the stance that US citizens would be unable to cope without phosphate detergents, and the Nixon administration agreed. “Elimination of phosphates is desirable in concept but not feasible for implementation at this time,” a Nixon staffer testified.³³

Industry scientists began to claim that phosphorus was not the limiting nutrient affecting algal blooms after all; the culprit was carbon, they said. There was no real evidence for this assertion. It made little sense—carbon is taken from the atmosphere by every kind of green plant during photosynthesis, including algae and aquatic grasses. Elemental phosphorus, on the other hand, originates only in certain kinds of rock, and its availability in lakes and rivers had been drastically increased by human doings, including the nineteenth-century shift from privies to sewage systems, the use of artificial fertilizers, and the rise of phosphate detergents.³⁴

Pinpointing the nutrients that cause eutrophication can be difficult, because most lakes have only been studied after years of pollution. “If we are to regard artificial eutrophication as a limnological experiment,” noted W.T. Edmondson, the limnologist who'd tracked the deterioration and recovery of Seattle's Lake Washington, “there is the awkward problem of a control. Very few situations have the experimental elegance of the upper and lower basins of Lake Zurich.”

Edmondson's data on Lake Washington's recovery was, however, the next-best thing. The lake's algal blooms and turbidity had declined at a rapid rate that correlated with the decreasing concentrations of phosphorus in the water as sewage flows were diverted to Puget Sound. Because secondary sewage effluents

are rich in phosphorus, the diversion had made a major impact on phosphorus concentrations, and a relatively minor one on those of nitrogen and carbon. The lake's dramatic recovery reinforced the idea that phosphorus was the key nutrient leading to algal blooms in fresh waters.

At a 1971 symposium on nutrients and eutrophication, a long debate followed Edmondson's presentation on Lake Washington. Frank Derr, a scientist working for the detergent industry, made a convoluted argument that attempted to turn the data inside out. Algae had declined because of the slight decrease in carbon loads, he claimed, and the decrease in algal numbers had somehow lowered phosphate concentrations in the lake.³⁵ "I'm not persuaded," Edmondson drily responded. His colleague, Joe Shapiro, put it more strongly: "That's like claiming that lung cancer causes cigarettes," he said.³⁶

John Vallentyne, a Canadian limnologist with a knack for cutting through the clouds of verbiage surrounding pollution controversies, pointed out a correlation between increasing algal blooms in the Great Lakes and the rising use of phosphate detergents. He charged the US Soap and Detergent Association with a deliberate campaign to confuse the public about the most straightforward way to control eutrophication. Vallentyne was head of the new Eutrophication section at the Freshwater Institute in Manitoba, a part of the Canadian Department of Fisheries and Oceans.

"Limnologists will still be arguing 100 years from now about whether this or that nutrient is more growth-controlling in different lakes," he told the symposium. "Regardless . . . phosphorus can be made to be growth-limiting by removing it from man-made sources that enter the lake."

Vallentyne had already helped to convince the Canadian government to ban phosphate detergents in provinces within the Great Lakes watershed. He was fed up with the US government's failure to act, but he also had an ace in the hole. In the Canadian wilderness, a group of scientists he'd recruited were at work on an unprecedented series of experiments that would silence the loud protests of the detergent industry.

David Schindler spent the winter of 1968–69 dragging heavy bags of synthetic fertilizer across the frozen surface of a series of pristine lakes in remote northwestern Ontario. The lakes lay in a roadless area, so Schindler and a colleague, Greg Brunskill, built some sleds they could load with bags of fertilizer and tow behind snowmobiles.

That year, the lake ice was slushy, making it impossible for the gutless snowmobiles of the time to cross. (The snow machines of the 1960s packed only twelve-horsepower engines. Unlike the modern versions, which zip over snow and ice pushed by more than 100 horsepower, they wallowed and lurched.) So Schindler and Brunskill tramped out five miles of trail in their snowshoes, then returned to run the snowmobiles across the track they'd created. The last half-mile of their journey was a steep, twisting trail full of sharp turns to avoid boulders and trees. The two men had to unhitch their sleds, sling a single eighty-pound bag of fertilizer across the snowmobile's saddle, and sit on top of it while they weaved their way to the untouched lake they intended to pollute.

“We thought it was fun,” Schindler would recall forty-six years later. “It was a big adventure.”

Schindler, then an ecologist in his late twenties, had been assigned to set up the Experimental Lakes Area. He would head a band of scientists who strategically polluted untouched lakes in order to puzzle out the specific cause of eutrophication. In the autumn of 1968, Schindler set up a makeshift camp in an Ontario forest dominated by black spruce and jack pine. The rocky soil of the region was so thin that the trees took eighty to one hundred years to grow to a height that made them worth the effort to cut them down and haul them to a lumber mill.³⁷

There was little organic matter running off the surrounding landscape, so the many small lakes in the region held little carbon. Schindler chose a lake numbered 227, which had the lowest levels of dissolved carbon ever recorded in the annals of limnology, as the ideal place to test the detergent industry’s hypothesis that carbon drives the growth of algal blooms. When he and his colleagues added a mix of nitrogen and phosphorus to Lake 227, it was transformed from clear water to a teeming green soup in a matter of weeks. The phosphate they added to the water was instantly taken up by algae, which drew carbon out of the atmosphere to support their growth.³⁸

To confirm the finding that algal blooms are created by an overload of phosphorus, Schindler altered another small lake. Dubbed Lake 226, it was shaped like an hourglass, with two basins separated by a narrow neck. Schindler used a vinyl sea curtain to separate the two basins. Then he ran his experiment, adding nitrogen and carbon to both sides of the lake but phosphorus only to one. The phosphorus-laden northeast basin soon produced a bloom of cyanobacteria. Schindler published his results in the journal *Science* in May 1974, effectively shutting down the argument that carbon could fuel eutrophication. An aerial photo of Lake 226, its southwest basin clear while its phosphorus-polluted northeast half held a dense algal bloom darker than the surrounding forest, ran alongside his article. That striking image became an important tool in convincing policymakers in North America and Europe that phosphorus was the critical element to control in fresh waters.

“It was a very convincing example of the old adage that a picture is worth a thousand words,” says Schindler. “Often the people making the decisions had no science background, but they understood what that picture meant.”

In his *Science* article, Schindler urged the US government to ban phosphate detergents, as the Canadian provinces bordering the Great Lakes and the states of Indiana, Michigan, and New York had already done.

Estuaries around the US and the developed world were also suffering from eutrophication. In Galveston Bay on the Texas Gulf Coast, fish kills caused by oxygen depletion happened on a regular basis. A heavy rain in Houston flushed polluted water into the lower bay in 1968, killing 30,000 fish.³⁹ The stench of rotting carcasses was intense enough to drive people out of their waterfront homes. Chesapeake Bay was smothering under an onslaught of nutrient-rich runoff from farms and city streets. When Tropical Storm Agnes struck in 1972, the load of silt

that flowed downstream smothered aquatic grasses from the mouth of tributary streams like the Susquehanna River to the salty lower bay.

Estuaries and marine coastal ecosystems would prove to be strongly affected by nitrogen pollution. Eutrophication in these habitats would boom during the 1970s due to increasing nitrogen loads from artificial fertilizers and atmospheric fallout of nitrogen from fossil fuel combustion. It would take a long time for scientists to puzzle out the differences between marine and freshwater eutrophication, and even longer for regulators to begin to respond. The EPA began regulating discharges of phosphorus in the 1970s but did not begin a comparable process for nitrogen until 2001.⁴⁰

As the science of water pollution advanced in the 1960s and 1970s, environmental law was also evolving. Legal protection of ecosystems was a new concept, and crafting legislation for the purpose was a struggle. Industrial polluters opposed a strong federal law controlling water pollution. So did the Nixon administration and officials in many of the states.

State and local governments had always held power over decisions on development and discharges in and around rivers, lakes, and estuaries. Waterways were given designated beneficial uses, which often gave a stamp of approval to pollution. Beneficial uses might range from swimming and fishing to, as in the case of the inner harbor in Los Angeles, acting as a cesspool for industrial waste. In the mid-twentieth century, as awareness of water pollution problems grew, Congress made some attempts to force the issue. The Federal Water Pollution Control Act of 1948 had, for the first time, authorized the US Public Health Service to intervene to abate interstate pollution. The federal agency had no real enforcement powers, however, and any action it might take was subject to the approval of state officials. Congress voted to amend the law in 1956, adding a provision for substantial federal grants to aid the construction and upgrade of sewage treatment plants. In vetoing the 1956 legislation, President Eisenhower wrote that water pollution was a “uniquely local blight,” and that responsibility for solving the problem should remain with state and local governments.⁴¹

That attitude changed during the Kennedy and Johnson presidencies. Senator Edmund Muskie, Democrat of Maine, would play a major role in the fight for strong federal antipollution laws. (His counterpart in the House was Representative John Blatnik of Minnesota.) In 1963, as a member of a special Senate Subcommittee on Air and Water Pollution, Muskie introduced a bill that called for creation of a Federal Water Pollution Control Administration (FWPCA). His original bill mandated federal water quality standards for wastewater discharges as well as receiving waters, a radical notion at the time. After a long process of debate and compromise, the bill became law in the autumn of 1965. The final Water Quality Act of 1965 left primary responsibility for water pollution control to the states, which were ordered to set water quality standards for lakes, rivers, and coastal waters—a strategy intended to push states beyond the assumption that waters could be fouled if that was their official use. The FWPCA was created and given limited authority to intervene when the states failed. The

idea of regulating pollutant loads in wastewaters had fallen away, but the act doubled the funding of federal grants for wastewater treatment facilities.

By the mid-1960s, the FWPCA had brought abatement actions against automobile factories and other polluting industries on the Detroit River, and against communities whose raw or poorly treated sewage was discharging into Lakes Erie and Michigan. The abatement proceedings moved at a glacial pace through the federal courts. Meanwhile, the federal government was nearly \$1 billion behind in funding grants promised to various cities to help improve their sewage plants.⁴² The city of Detroit, for instance, had been pledged \$10 million in federal wastewater treatment grants, of which it had received only 20 percent.⁴³

By 1966, Muskie and his subcommittee had been holding hearings around the country for three years. Again and again, they heard that the major obstacle to water quality improvement was the lack of funding for city sewage treatment plants. Muskie proposed a massive increase in federal construction grants. Congress eventually approved \$3.55 billion over five years, a little over half what Muskie had asked for.

In the same year, the US Supreme Court heard a case in which Standard Oil had been charged with violating an obscure law, the Rivers and Harbors Act of 1899, by releasing high-octane aviation fuel to the St. Johns River in Florida. The Rivers and Harbors Act had evolved from a statute written to protect New York Harbor, where in the mid-1800s ships were colliding with heaps of solid waste dumped into the water. An 1886 law prohibited dumping “any ballast, stone, slate, gravel, earth, slack, rubbish, wreck, filth, slabs, edgings, sawdust, slag or cinders, or other refuse . . . into New York Harbor.”⁴⁴ Over time the statute was broadened to cover waters nationwide. In 1899 the Rivers and Harbors Act was amended to prohibit dumping of “any refuse matter of any kind or description,” aside from sewage effluents and stormwater runoff.⁴⁵ Any exceptions had to be permitted by the US Army Corps of Engineers.

Standard Oil’s attorneys argued that the aviation fuel it had released to the St. Johns was commercially valuable and therefore did not qualify as “refuse.”

“Oil is oil,” Justice William O. Douglas wrote in the Supreme Court’s decision on the case. “Whether useable or not by industrial standards it has the same deleterious effect on waterways.” This commonsense ruling came as a bombshell to industrial polluters. The decision made clear that release of any kind of pollutant to US waterways was illegal, unless a permit had been granted by the Army Corps of Engineers. The Rivers and Harbors Act imposed fines on polluters and allowed payment of a portion of these fines to citizens who alerted authorities to violations. The law’s resurrection triggered a brief flurry of lawsuits against industrial polluters, brought by individual citizens and environmental groups.

The Court’s reinterpretation of the Rivers and Harbors Act also brought forward the notion of a federal agency with the power to control and permit discharges of pollutants. That idea would help build the law that revolutionized water pollution control in the US, the CWA of 1972. The new law would give regulatory power over city sewage and industrial waste discharges to the EPA, created by President Nixon in 1970.

Nixon objected to everything about the CWA—especially the billions of dollars in federal money it appropriated for sewage plant construction. Nixon was no environmentalist. He created the EPA, a strong step toward federal regulation of pollution nationwide, but only because he was forced into it⁴⁶ Every member he appointed to the National Pollution Control Council, a Commerce Department board, was a corporate executive.

Nixon traveled to Canada to sign the first US–Canada Great Lakes Water Quality agreement in April 1972. At that time he was exerting every kind of pressure he could muster to defeat Muskie’s new clean water bill. In November 1971 Muskie’s 180-page bill was passed unanimously by the Senate. The legislation, which would become known as the Clean Water Act, contained sweeping changes. For the first time in US history, it declared a legal intent to restore and maintain aquatic ecosystems. It transferred authority over effluents from sewage treatment plants and industrial wastewaters from the states to the federal EPA and set a wildly idealistic goal that all such discharges into US waters should cease by 1985. In a more pragmatic provision, the law required that any city or industry that could not reach the “zero discharge” goal must use the best available technology to treat its effluent.

The notion of technology-based regulation of discharges was unprecedented. Previous federal and state law had required agencies to set allowable levels of pollutants in receiving waters. This practice implicitly acknowledged a right to pollute, and fit with sanitary engineers’ traditional philosophy that “dilution is the solution to pollution.” The Senate version of the CWA rejected that view.

Under the old regime of setting pollutant standards for receiving waters, any enforcement action required the government to prove that a particular industry or sewage plant was responsible for degrading a body of water. Most often it was impossible to make cause-and-effect links between specific discharges and water quality problems.⁴⁷ Enforcement of technology-based standards would be much more straightforward.⁴⁸ To enable communities nationwide to build the best available wastewater treatment technology, the Senate recommended an appropriation of \$14 billion.

The House was expected to be less amenable to strict new environmental restrictions. The Nixon administration pushed for representatives to rewrite the bill in a way that would restore primary authority to the states, water down federal enforcement, and, most importantly, slash federal funding. Russell Train, chair of the President’s Council on Environmental Quality, circulated an estimate that the cost of eliminating all pollutants from industrial and municipal sources by 1981 would run to \$94.5 billion. Muskie described this estimate as an attempt “to frighten the people and intimidate the Congress.”⁴⁹

Regardless of presidential pressure, the House raised the budget for sewage plant construction from the Senate’s \$14 billion to more than \$20 billion. (“The Nixon administration,” says one historian, “was apoplectic.”⁵⁰) The main features of the Senate bill survived and the law passed the House with a wide majority. Nixon vetoed it, citing what he called its “staggering” cost. Both the Senate and the House voted to override the president’s veto, and the CWA became law on October 18, 1972.

Under the CWA, pollution from sewage and industrial wastes has been dramatically decreased—so much so that even Lake Erie experienced a temporary revival. Still, looking back more than four decades later, major flaws in the legislation, and in the way it was implemented, stand out.

The law failed to effectively address nonpoint source pollution—runoff from farm fields and city streets. In the 1970s, it was already clear that nonpoint pollution was a serious problem. A federally sponsored 1974 study found that urban runoff contributes 40 to 80 percent of the organic matter in affected waters, and the level of toxic material in urban runoff exceeded the amounts in typical industrial discharges.⁵¹ David Schindler predicted in 1976 that the Great Lakes would not recover unless nonpoint pollution was controlled—a forecast that has proven particularly relevant in Lake Erie. Today nonpoint sources are the major cause of pollution in US waters. Runoff is the reason that Chesapeake Bay, Lake Erie, and the northern Gulf of Mexico experience dense algal blooms and contain large dead zones. As for the fate of wetlands, now seen as critical natural filters for nonpoint pollution, the original Act failed to mention the word “wetlands” at all. Still, it has become, at least in theory, a tool in the struggle to keep wetlands from vanishing in the US.

The CWA promised federal money to cover 75 percent of the cost of sewage treatment plant construction, a provision that became one of the greatest public works goldmines in US history. During the first three years of the CWA, President Nixon impounded half the funds authorized by Congress for sewage treatment plant construction: \$9 million out of \$18 million.⁵² Nixon’s habit of impounding funds when he disapproved of Congress’ spending decisions sparked a running feud over control of the federal purse strings. The issue was resolved by a 1975 Supreme Court decision. In the case *Train v. City of New York*, the court ruled that “the president cannot frustrate the will of Congress by killing a program through impoundment.”⁵³ This led to the release of the CWA funds. Nixon had resigned months earlier.

The delay in funding didn’t stop a juggernaut of planning and construction for elaborate regional sewage systems. Engineers were paid a percentage of total costs, giving them an incentive to build the most grandiose projects possible. In the mid-1970s, federal funding for sewage treatment plants was in the billions, approaching the amount spent on hydroelectric dams, flood control projects, and public power plants combined. EPA gave priority to construction of conventional sewage treatment systems, declined to fund projects aimed at treating urban runoff, and set short deadlines for grant funding that forced state and local governments to apply in a rush.

All this intensified the innate tendency of government bureaucrats and their consulting engineers to turn to familiar, high-tech conventional treatment. The letter of the CWA required cities to provide secondary treatment by 1983, and the consulting engineers of the nation interpreted this to mean that every town needed an activated sludge system, the approach that cost the most to build and maintain and that sucked down the most energy. More economical kinds of secondary treatment, such as trickling filters and oxidation ponds, were ignored.

As early as 1976, John Rhett, a deputy assistant administrator at⁵⁴ EPA, wrote to his superiors to warn them that many small communities were being saddled with elaborate sewage systems they could not afford to build or maintain. He mentioned Humboldt County, California as an example.

EPA would come to understand the problem, but it took time, and resistance from communities scattered around the country. In Mayo, Maryland, a small town on the eastern shore of Chesapeake Bay, locals fought construction of a huge \$20 million sewage plant. “Despite their admittedly serious water pollution problems, citizens’ groups are calling for smaller, less costly solutions . . . because of the massive development it would permit along the now deserted bay shore,” the *New York Times* reported in June 1979.⁵⁵ Developers lobbied for major sewage construction projects, while activists in communities scattered across the country began to resist plans for high-tech regional sewage systems. The parallels with Arcata’s opposition to the proposed regional sewage system in Humboldt County were obvious. What made Humboldt unique was that its citizens saw the problem coming sooner than most—and that they’d wind up finding their own unorthodox solution.

By 1981, President Reagan was describing the CWA grant program as “a wasteful federal subsidy for urban sprawl.”⁵⁶ Some environmentalists agreed—a rare event during Reagan’s presidency. “We have been spending too much on fancy treatment plants and using the program to help developers spread suburbia,” said Larry Silverman, director of the American Clean Water Association. In the early 1980s, federal construction funding was slashed and EPA requirements were changed, allowing communities to keep or construct oxidation ponds and other low-tech treatment systems, so long as effluent quality standards were met.⁵⁷

These changes came after local activists had already waged a long battle against the regional sewage system planned for Humboldt Bay. In their obscure rural corner of California, these passionate sewage objectors had to invent a way to defeat the juggernaut of sewage construction on their own.

NOTES

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